AMATEUR RADIO ON THE INTERNATIONAL SPACE STATION (ARISS)

25 Years of Continuous Operations on ISS

AMSAT Symposium, October 17, 2025

Amateur Radio on the International Space Station (ARISS)

Inspire | Explore | Experiment

- An independent, backup communications capability for ISS
- Boosts ISS crew morale through enriching youth, community and amateur radio engagement
- Inspires, engages and educates K-16 youth in STEM/STEAM via 10-minute amateur radio contacts with the on-orbit crew; a workforce development powerhouse
- Regular school contacts keep astronauts proficient in ARISS radio and ground stations proficient in ISS communications
- During 4-to-6-month pre-contact preparations, students learn about space exploration and science research, space communications, radio science & technology with amateur (ham) radio, and on-going ISS research activities

ARISS USA SPONSORS

NASA/Space Communication and Navigation (SCaN)

ISS U.S. NATIONAL LABORATORY

AMATEUR RADIO DIGITAL COMMUNICATIONS

Amateur Radio Leadership

American Radio Relay League (ARRL)

AMSAT Radio Amateur Satellite Corporation

Includes real (money) contributions and in-kind (support) contributions

AMATEUR RADIO ON HUMAN SPACEFLIGHT VEHICLES (1983-PRESENT)

Space Shuttle
(1983-1999)

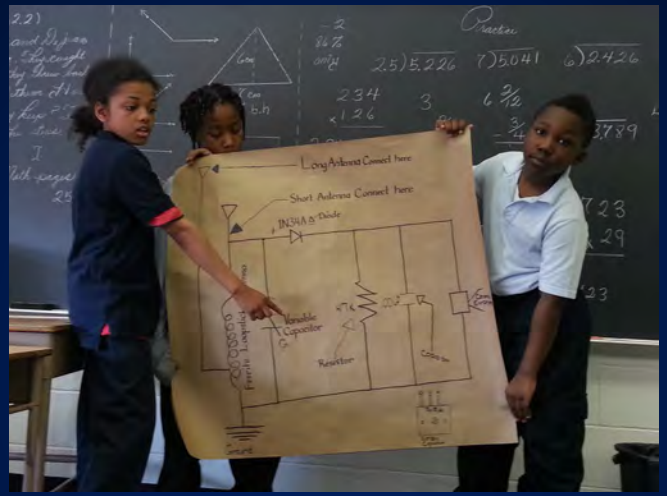
Mir
(1995-1998)

ISS
(2000-Present)

Fram2/Dragon
(2025)

ARISS PRIME INITIATIVES

STEM/STEAM Education (Workforce Development)



Spaceflight Hardware Development

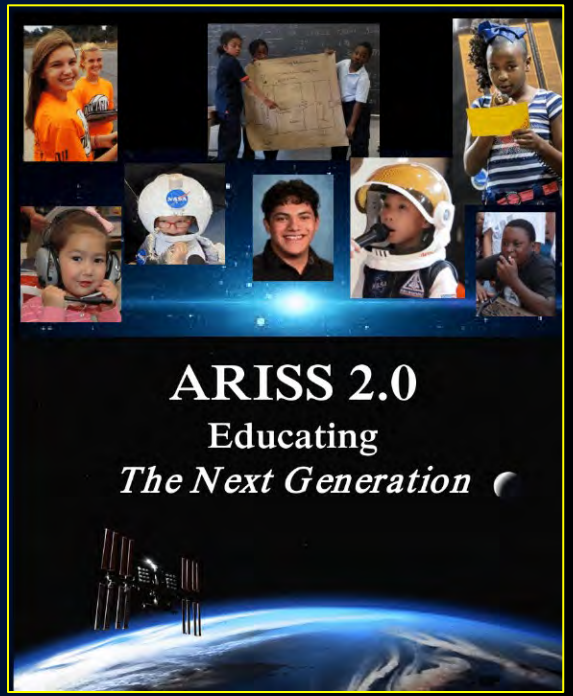
ARISS Initiatives Performed Almost Exclusively by an International Volunteer Team

Spaceflight Operations

ARISS 2.0: EDUCATION VISION FOR THE FUTURE

INSPIRE, ENGAGE, AND EDUCATE STUDENTS & LIFELONG LEARNERS

- More extensive educational outcomes for all
- Engaging education projects and lesson plans
- Multiple space stations: ISS and Commercial
- Lunar Orbiters and Landers
- Available 24/7!



<u>Initiatives underway</u>

- ARISS payload now a facility on ISS
  - *Enables partnerships employing ARISS facility*
- Expansion to Axiom commercial space station flights
- Expansion to Crew Dragon via Fram2Ham
- More SSTV opportunities
- Educational Extension Initiatives (with grants):
  - ***STEREO/SPARKI***
  - ***ARISS *STAR****
  - ***Student Mission Control***

ARISS 2.0
A NEW HOPE

2025 ARISS ACCOMPLISHMENTS

Fram2

Axiom-4

SSTV Ops

Hope Lea at SpaceOps

Field Day Ops

HamTV Install

- **Celebrating 25 years of continuous operations on ISS!**
- **School/organization contacts:** 59 to date
- **SSTV ops:** A record 6 events, including Fram2Ham Polar Puzzle
- **HamTV**: Launch of HDMI Converter on Crew 11 and inaugural ops of HamVideo!!
- **Spectrum Protection**: FCC comments sent protesting AST SpaceMobile's use of 70 cm for satellite ops
- **USSRC Museum**: SAREX flight hardware temporary display
- **General QSOs**: Crew on the air during Field Day and many other times
- **Youth Best Paper Award**: Hope Lea, ND2L and Ruth Willet KM4LAO win best paper award at SpaceOps International Conference, Montreal
- **Mission Accomplished!** Pioneering Fram2 mission—first in a Dragon Capsule
- **Mission Accomplished!** Axiom-4 commercial spaceflight to ISS with three international private astronauts on-board
- **Mission Accomplished!** Italian Space Agency NAVCOM Lunar GNSS experiment using ARISS L/S-band antennas

FRAM2

FIRST HUMAN SPACEFLIGHT MISSION TO ORBIT THE POLES

Mission Accomplished!!

Fram2-ARISS Collaboration: Fram2Ham

FRAM2 CREW

Eric Phillips
Mission Specialist And Medical Officer

Jannicke Mikkelsen
Vehicle Commander

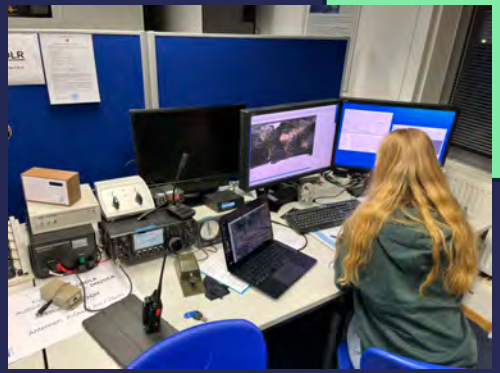
Chun Wang
Mission Commander

Rabea Rogge
Pilot
LB9NJ (Norway)
KD3AID (USA)

Architecture of the Educational Outreach Plan for Fram2Ham

Main Components of Fram2Ham Competition:

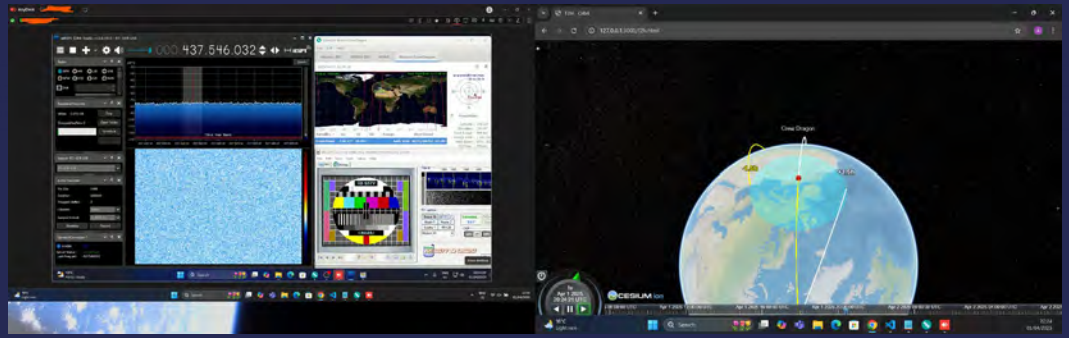
- **SSTV competition for 16–25-year-old students**
- **Registration was required**
- **3-5 educational institutions per team**
- **International teams encouraged**
- **Discord used for communications**



There Were Two Parts To Offical Team Entires

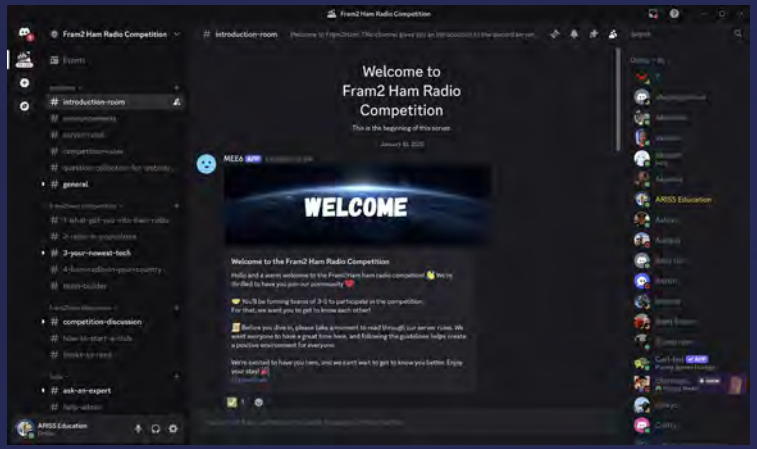
Part One:
Create international teams, team captures 12 Robot 36 SSTV puzzle images, and submit to SSTV gallery

Part Two:
Unscramble puzzle pieces into 3 geographical locations, answer location-specific polar history questions & Submit Testmoz team entry form



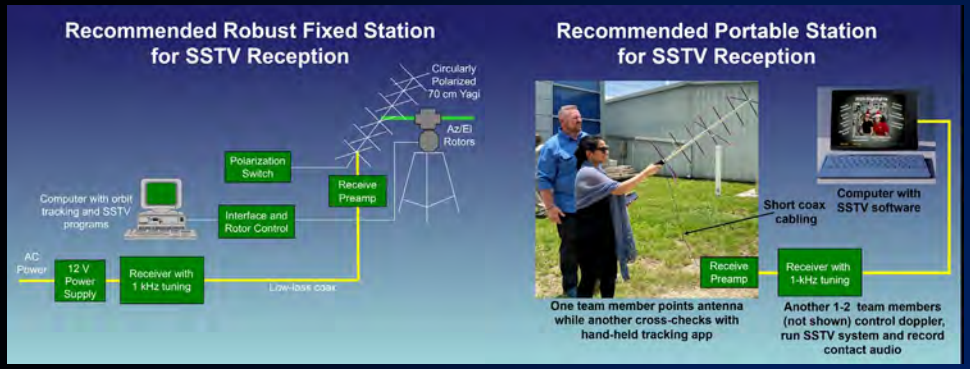
How ARISS supported the Fram2Ham competition

Competition Manual	**Informational Webinar**	**Discord Channel Moderation**	**TLEs & Doppler Shift Charts**	**Team Registrations**	**Handled Results**

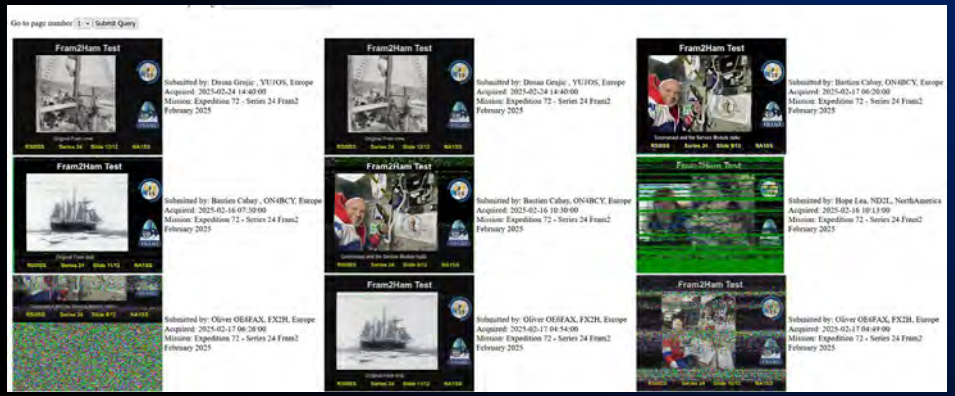


PRE-FLIGHT OPERATIONS GUIDANCE TO YOUTH
"TEST LIKE YOU FLY"

Station Recommendations


Recommended Robust Fixed Station for SSTV Reception
Circularly Polarized 70 cm Yagi
Az/El Rotors
Polarization Switch
Receive Preamp
Computer with orbit tracking and SSTV programs
Interface and Rotor Control
AC Power
12 V Power Supply
Receiver with 1 kHz tuning
Low-loss coax
Recommended Portable Station for SSTV Reception
Computer with SSTV software
Short coax cabling
Receive Preamp
Receiver with 1-kHz tuning
One team member points antenna while another cross-checks with hand-held tracking app
Another 1-2 team members (not shown) control doppler, run SSTV system and record contact audio

Fram2Ham Simulation



Doppler Correction Tables for Fram2Ham SSTV

Here are some Doppler Correction Tables that might help you. While we provided a table for 5 KHz frequency steps (such as with an HT) these will not work too well.

For the ISS Fram2Ham simulation, here are suggested ways to program your radio to receive the downlink. The Doppler shift at 437.550 MHz is approximately +/- 10kHz.

If your radio can be programmed in 1kHz steps (highly suggested), then this should help for the ISS test of the Fram2Ham event:

Memory location	Doppler Khz	Spacecraft transmits down	We listen at	
1	10	437.5500	**437.5600**	AOS
2	9	437.5500	**437.5590**	AOS
3	8	437.5500	**437.5580**	
4	7	437.5500	**437.5570**	
5	6	437.5500	**437.5560**	
6	5	437.5500	**437.5550**	
7	4	437.5500	**437.5540**	
8	3	437.5500	**437.5530**	
9	2	437.5500	**437.5520**	
10	1	437.5500	**437.5510**	
11	0	437.5500	**437.5500**	TCA
12	-1	437.5500	**437.5490**	
13	-2	437.5500	**437.5480**	
14	-3	437.5500	**437.5470**	
15	-4	437.5500	**437.5460**	
16	-5	437.5500	**437.5450**	
17	-6	437.5500	**437.5440**	
18	-7	437.5500	**437.5430**	
19	-8	437.5500	**437.5420**	
20	-9	437.5500	**437.5410**	LOS
21	-10	437.5500	**437.5400**	LOS

If your radio can be programmed in 1.5kHz steps, this should help for the ISS test of the Fram2Ham event:

FLIGHT OPERATIONS (1/2)

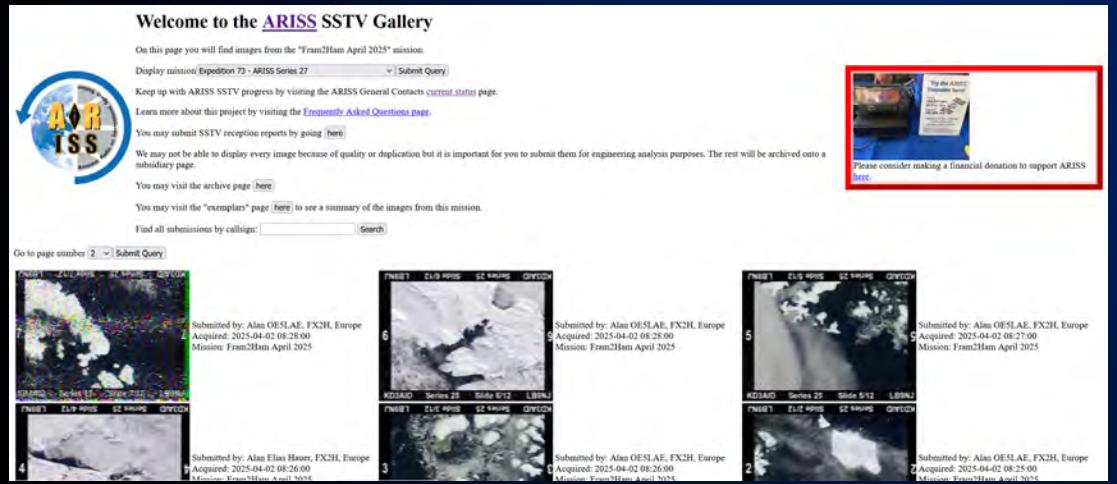
Keplerian Elements

Fram2 1 April 0320 UTC Launch Opportunity

1 90000U 25090A 25091.24166955 -.00012090 00000-0 -25444-3 0 65

2 90000 90.0015 341.9186 0001128 47.8434 312.3114 15.45593922 33

Robot 36 SSTV Image Downlinks & SSTV Gallery


Welcome to the ARISS SSTV Gallery
On this page you will find images from the "Fram2Ham April 2025" mission.
Display mission Expedition 73 - ARISS Series 27 Submit Query
Keep up with ARISS SSTV progress by visiting the ARISS General Contacts current status page.
Learn more about this project by visiting the Frequently Asked Questions page.
You may submit SSTV reception reports by going here
We may not be able to display every image because of quality or duplication but it is important for you to submit them for engineering analysis purposes. The rest will be archived onto a subsidiary page.
You may visit the archive page here
You may visit the "exemplars" page here to see a summary of the images from this mission.
Find all submissions by callsign: Search
Go to page number 2 Submit Query
Please consider making a financial donation to support ARISS here.
Submitted by: Alan OE5LAE, FX2H, Europe
Acquired: 2025-04-02 08:28:00
Mission: Fram2Ham April 2025
Submitted by: Alan OE5LAE, FX2H, Europe
Acquired: 2025-04-02 08:27:00
Mission: Fram2Ham April 2025
Submitted by: Alan Elias Hauer, FX2H, Europe
Acquired: 2025-04-02 08:26:00
Submitted by: Alan OE5LAE, FX2H, Europe
Acquired: 2025-04-02 08:26:00
Submitted by: Alan OE5LAE, FX2H, Europe
Acquired: 2025-04-02 08:25:00

Fram2Ham Award

FIRST HUMAN SPACEFLIGHT TO EARTH'S POLAR REGIONS
FRAM2 HAM AWARD
No 25278
Frank Bauer KA3HDO
Received SSTV images broadcast from the Fram2 spacecraft, as part of the Fram2 Ham competition. The pioneering Fram2 mission is the first crewed flight over the Earth's poles and Fram2Ham is the first human tended amateur radio operations from a small spacecraft. Fram2Ham was made possible through the support of amateur radio astronaut Rabea Rogge.
Chun Wang
MISSION COMMANDER
Jannicke Mikkelsen
VEHICLE COMMANDER
Rabea Rogge LB9NJ, KD3AID
PILOT
Eric Philips
MISSION SPECIALIST AND MEDICAL OFFICER
FRAM2
First men at the pole - 1911, Roald Amundsen, Helmer Hanssen, Sverre Hassel, Oscar Wisting
FRAM2 HAM COMPETITION
April 1 - 4, 2025

FLIGHT OPERATIONS (2/2)

Voice Contact with TU Berlin

Mission Updates on Discord

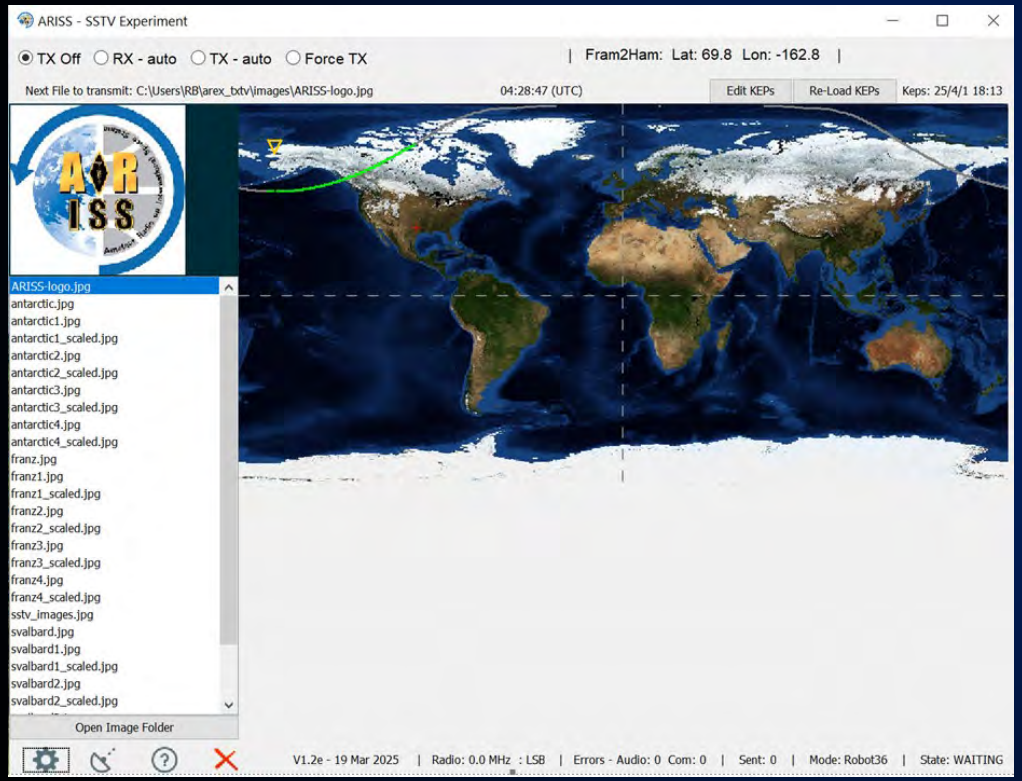
Fram2Ham Participants:

The Fram2 mission recently ended with a successful splashdown at 16:19 UTC at the Oceanside area of the Pacific Ocean… this amateur radio experiment—our first in a Dragon Capsule—was incredible. It far exceeded our wildest dreams!...

ENGINEERING CONTRIBUTIONS

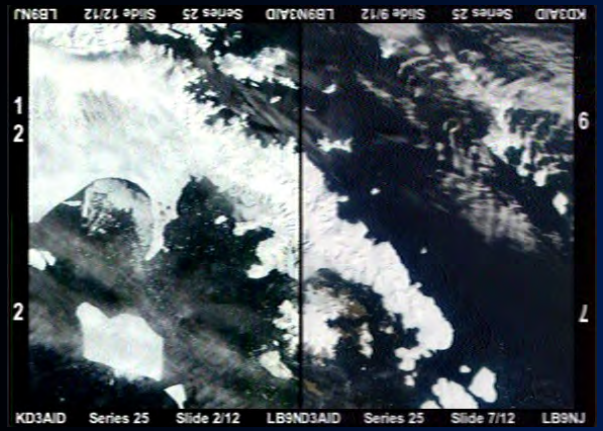
- Optimizing Existing Antenna for 70 cm Ops
  - Developed Impedance Matching Circuit to improve SWR
  - Antenna Pattern and signal propagation unknown until flight—ops capabilities not fully known until first Fram2 signals from space
- Power Output
- New Automation software
  - Leveraging ARISS SSTV software
  - Integration of new features to minimize crew workload
  - Maximizing Voice and SSTV capabilities
- Met SpaceX certifications
  - Falcon 9 and Dragon

ARISS SSTV SOFTWARE DEVELOPED FOR FRAM2



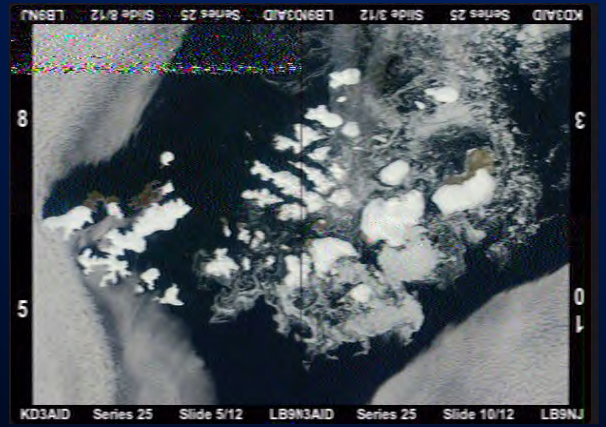
- Outstanding, automated SSTV capability realized on Fram2
- Can support future ARISS activities on ISS and other commercial lunar destinations (CLDs)
- ARISS thanks Chris Thompson, AC2CZ, VE2TCP, G0KLA for his exceptional software!!

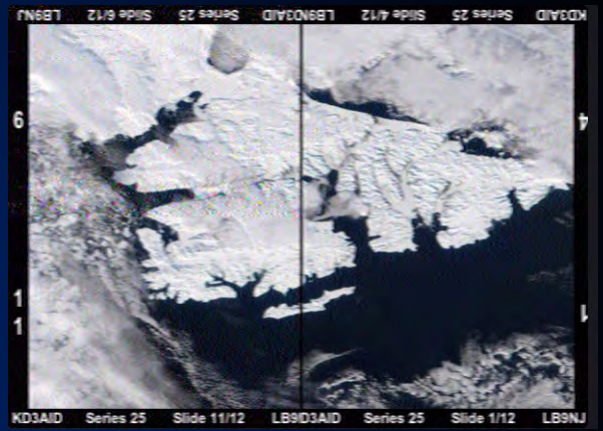
SSTV POLAR PUZZLES: SOLVED!



Antarctica

Franz Josef Land





Svalbard

Credit: Team Riceball

Fram2Ham Outcomes

Participating Team Locations

- Discord Participants: 718
- Number of Participating Teams: 14
- Number of Educational Institutions: 55
- Approximate learning hours per student: 25-50
- Gallery Picture Submitted: Competition teams: 308; Total Submissions: 1833
- Gallery Customers: 393
- Over 120,000 impressions on social media
- “Coursework”: Orbit Prediction, Radio Signal Propagation/Weak Signal Acquisition, Antenna Design, Construction & Antenna Characteristics (gain, beamwidth), Radio Reception Specifications and Characteristics, RF Filters and Pre-amplifiers, “Test Like You Fly”, Polar Exploration History, Geography, Leadership, Teamwork, International Collaboration

Quotes from Fram2Ham Youth Participants

"It doesn't matter what your resources are: just give it a try and enjoy the process - if results aren't great, for sure you'll have learnt a lot of things."

"Events like these should be more often! Yes, there are many SSTV events, but competitions/riddles that being together the international community is a great enabler for radio education."

"I started to design a 3D-printed Satellite Tracking Mount for my lightweight Yagis."

"It was neat to be able to share a bit of space history and be a part of the research."

"Amateur radio has the capacity to be highly engaging to my peers when the time is right! It also got my friends genuinely excited about communications technologies and the space industry."

AXIOM-4

INTERNATIONAL PRIVATE ASTRONAUT CREW TO ISS

Mission Accomplished!!

Collaboration

PREVIOUS COLLABORATIONS WITH AXIOM SPACE

Mark Pathy
Canada

Eytan Stibbe
Israel

AX-1 Mission
April 8-25, 2022

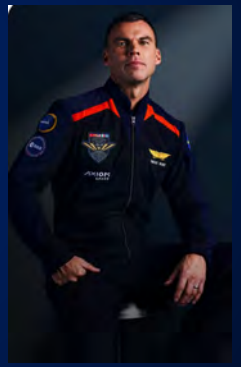
Ali
AlQarni
Saudi Arabia

John
Shoffner
USA

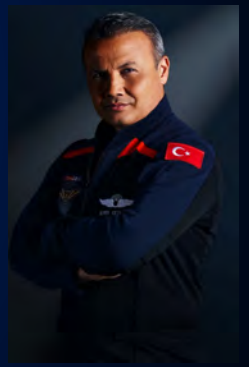
Rayyanah
Barnawi
Saudi Arabia

AX-2 Mission
May 21-31, 2023

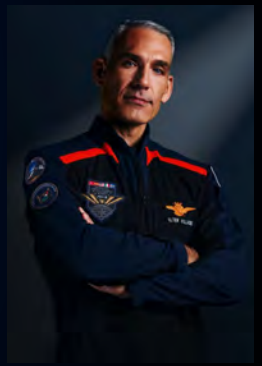
Marcus
Wandt
Sweden



Alper
Gezeravcı
Turkey



Walter
Villadei
Italy



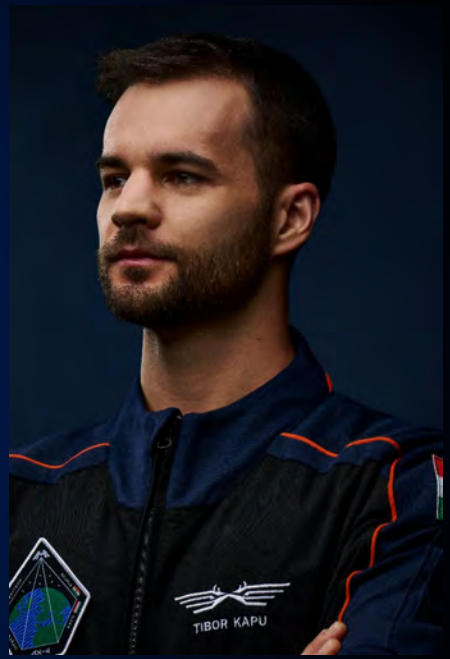
AX-3 Mission
January 18-February 9, 2024

Image Credits: Axiom space

AX-4 COLLABORATION WITH AXIOM SPACE

Shubhanshu Shukla
India

Sławosz Uznański-Wiśniewski
Poland



Tibor Kapu
Hungary

6 School Contacts; Request for QSO contacts with amateur radio community

Ax-4 Launch: June 25; Splashdown: July 15, 2025

Image Credits:
Axiom space

Axiom Ax-4 Mission

Axiom's fourth trip to the ISS and ARISS' fourth time powering STEM contacts!

Shubhanshu Shukla (VU2TNI) – representing India

- 04-July contact with UR Rao Satellite Centre at Bengaluru
  - *6.5K views of a non-sponsor YouTube stream!*
- 08-July contact with NE Space Applications Centre in Shillong

Sławosz Uznański-Wiśniewski (SQ7AS) – representing Poland

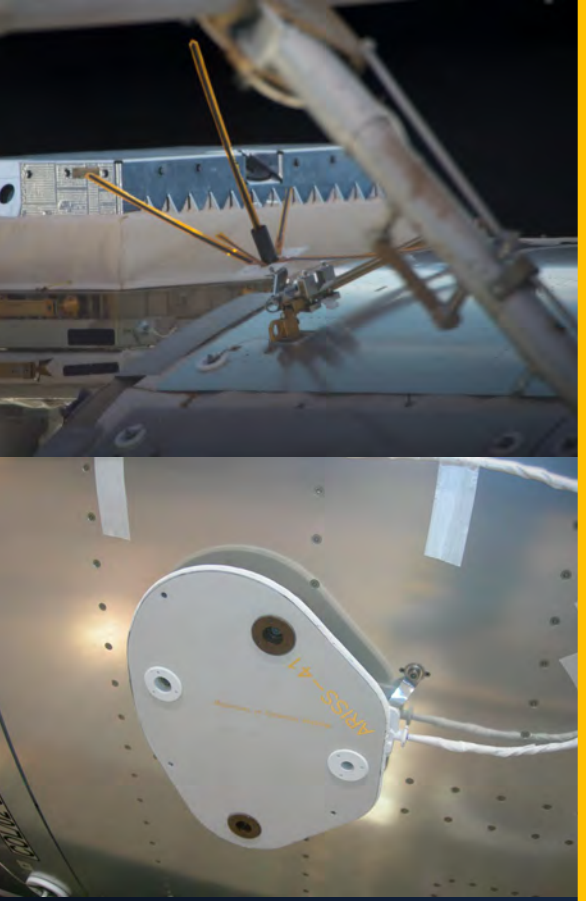
- 04-July contact with University of Wroclaw
- 05-July with Rzeszow University of Technology
  - *70,000 viewers of the live stream across Facebook and YouTube*

Tibor Kapu (HA5TRO) – representing Hungary

- 03-July contact with 4 groups in Budapest
- 09-July contact with Mobolis Interactive Science Center in Győr
  - 150 in person from 6-99 and more than 2,500 live stream viewers

Social media impact for Ax-4 was intense! During their ops period:

- *X: 8 of the top 10 ARISS posts were Ax-4 related*
- *Facebook: 10 of the top 20 ARISS posts were Ax-4 related*



VHF/UHF (Top) and L/S Band (Bottom) Antennas on ISS Columbus Module

Commercial Spaceflight Futures

First Step: External Antenna Interfaces

Antenna interface needs:

- RF Feedthrough Penetration
- Antenna mount area on Nadir facing side or along +/- velocity vector
- Launch loads and vehicle certification criteria

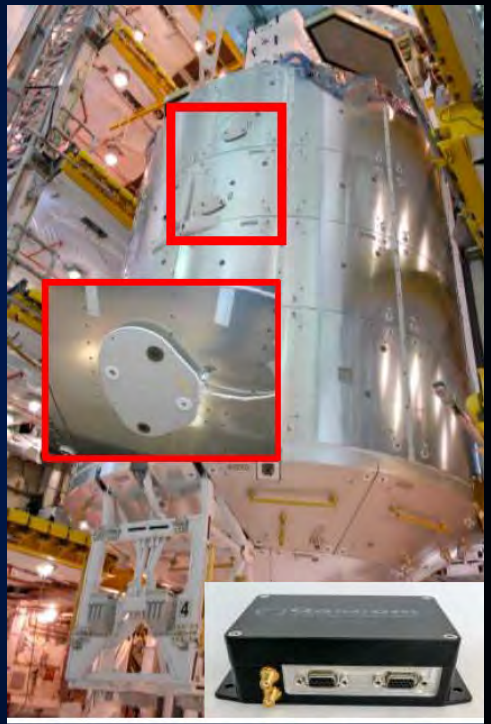
ARISS Can Supply:

- Flight certified antenna system and feedlines
- Can accommodate antennas that are mounted prior to launch
- Integration support

Mission Accomplished!!

NAVCOM EXPERIMENT

- Partnership between NASA, Italian Space Agency, QASCOM, and ARISS
- NAVCOM experiment launched to ISS late 2024 - installation and deployment in Spring of 2025
- In-situ demonstration of lunar navigation reception using QASCOM positioning, navigation, and timing (PNT) receiver
- QASCOM receiver, software-designed radio (SDR) technology, and ARISS' S-band antenna system on station processed navigation signals simultaneously from five ground stations on Earth



Preflight images showing L/S band antennas installed on the exterior of the Columbus Module. QASCOM receiver lower right corner.

HAMTV STATUS

Samantha Cristoforetti with HamTV in 2015

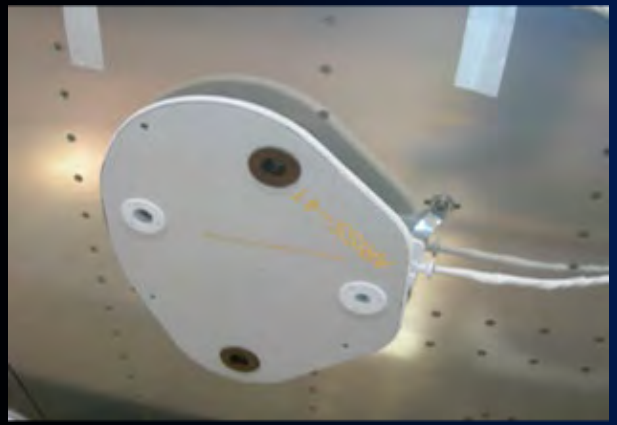
HAMTV TIMELINE

Feb 2016 first HamTV School Contact!

July 2025 Jonny Kim HamTV Reinstall

- March-April 2014—Series of HamTV operations (commissioning) tests performed
- February 2016--First school operations, Royal Masonic School for Girls, Rickmansworth, UK
- April 2018—On-orbit failure
- January 2019—returned to Earth for Repairs on SpaceX-19
- 2019-2024—Extensive repair, test, addition of RF filter, flight certifications and return to Space on SpaceX-30
- July 29, 2025—Astronaut Jonny Kim reinstalls HamTV; “Blank Screen” ops underway with live TV downlinks scheduling underway
- August 1 2025—Launch of HDMI Converter on Crew 11 to support new ISS HDMI cameras

HAMTV OPERATIONS SPECIFICATIONS



Columbus Module L/S Antenna Used for HamTV

Ham Video RF Transmissions

- Frequency: 2395 MHz
- Transmit power: 10 watts into an 8 db RHCP antenna with 8 dB cable losses and losses due to newly installed bandpass filter
- Modulation: DVB-S
  - *Symbol rates: 1.3 Ms/s or 2.0 Ms/s (2.0 Ms/s is normally used)*
  - *FEC : ½*
  - *Rolloff: 35%*

Resources

- ARISS Discord HamTV Channel
- BATC: https://wiki.batc.org.uk/HAMTV_from_the_ISS
- AMSAT-ON Website https://www.amsat-on.be/hamtv-summary/

NASA RFI: ARTEMIS-II ONE-WAY DOPPLER TRACKING

- NASA recently released Request for Information (RFI) soliciting organizations with ground station capabilities to inform NASA on how they may be able to execute tracking of the upcoming Artemis II mission planned for April 2026
- S-band 2200-2290 MHz reception; one-way (passive)—no transmissions; receive carrier signals for tracking purposes; telemetry collection not part of RFI
- https://sam.gov/workspace/contract/opp/50d4e81f54e34118a8164fb786b554a6/view
- **5-page (Max) RFI input due on October 27 (5 pm EDT)**

PROPOSAL: AMSAT-ARISS (AREx) RFI COLLABORATION

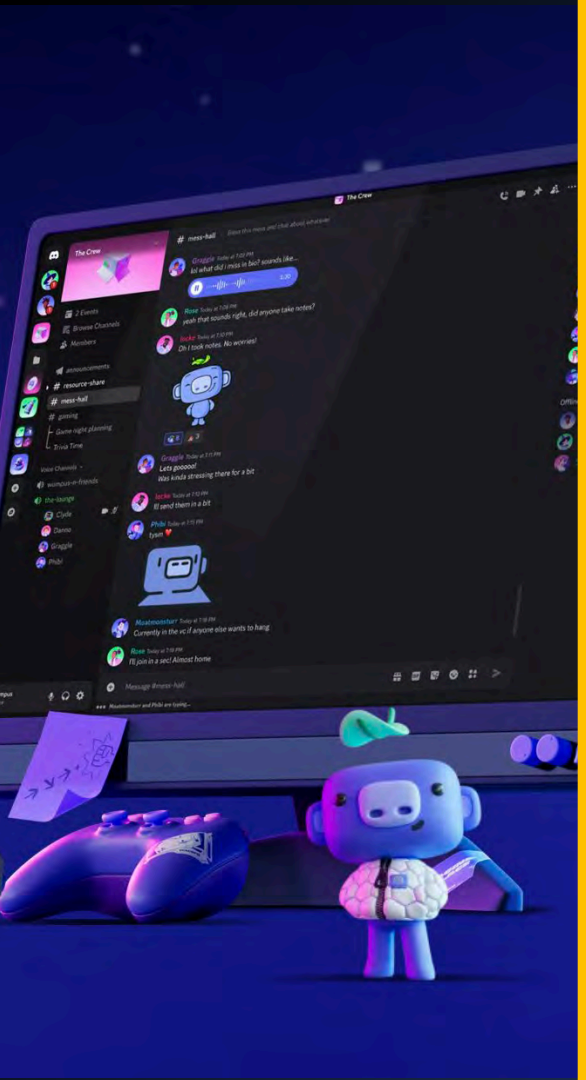
- Amateur Radio Exploration (AREx) was formed as an international amateur radio project with team members from AMSAT and ARISS; goal: lunar mission hardware development, operations and STEM education
- **ARISS suggests the development of an AREx consortium of ground stations to support NASA's Artemis-II one-way doppler initiative**
- AREx consortium would demonstrate the robustness of a coordinated amateur radio **"ground network"**
  - *More robust than individual ground stations*
  - *Provides one amateur radio voice into space agency*
  - *AREx big dishes (e.g. Bochum, others) will ensure the Artemis-II tracking requirement will be met*
  - *Allows some team members in the consortium to test and experiment with new ideas, including smaller dish antennas (< 9 m) and weak signal techniques that might augment 3-4 big AREx dishes*
  - *Team members who want to be part of the AREx/Artemis-II ground station consortium can submit individually to the (RFI) but should state in their submittal that they wish to be part of the AREx ground station consortium*
  - *Contact Frank Bauer at frank.bauer@ariss-usa.org if you want to be part of the consortium*

MISSION ACCOMPLISHED: GPS/GNSS RECEPTION ON THE LUNAR SURFACE

20+ years ago, AMSAT's AO-40 mission demonstrated that weak signal GPS could be used in high Earth orbit

In January-March 2025, LuGRE, on the Firefly Blue Ghost mission, extended GPS weak signal navigation to cislunar space, including on the lunar surface

Photo Credit: Firefly



Discord

830

Members since public launch!

June 22, 2025

ARISS Social Media Locations

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Summary

- Together, AMSAT and SAREX/ARISS have pioneered human spaceflight amateur radio, providing ham radio hardware systems for the Shuttle, Mir and ISS. Now we are certified on the Dragon Capsule
- Together, we have been working diligently on “Beyond LEO” ops, including lunar opportunities via AREx (Amateur Radio Exploration)
- Together, we have developed an outstanding Human Spaceflight STEAM education program for Youth and Lifelong learners
- ARISS 2.0 provides youth and lifelong learners 24/7, inspiring, engaging and educating activities for participants across the globe
- When ARISS and AMSAT collaborate, we do amazing things!!

The ARISS Experience

ARISS Information

https://www.ariss.org

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